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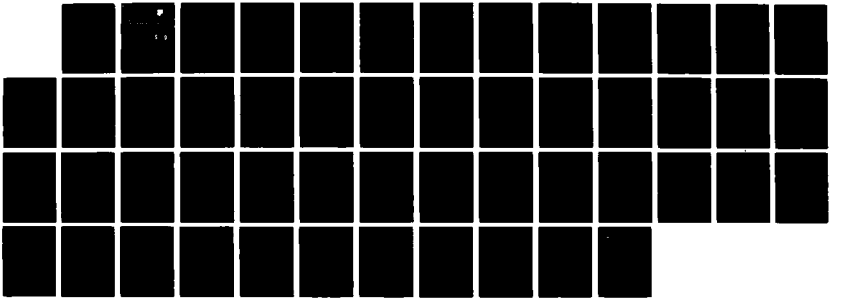

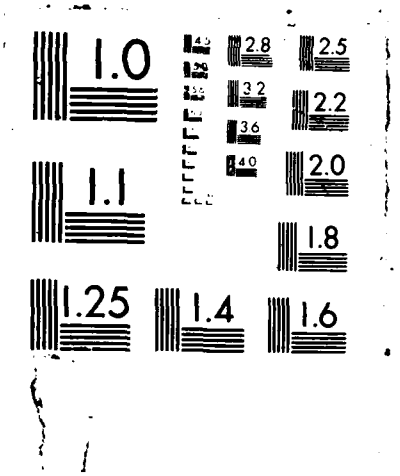
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RADC-TR-86-218, Vol I (of two)
Interim Report
July 1987

NORTHEAST ARTIFICIAL INTELLIGENCE CONSORTIUM (NAIC) Administrative Matters and Ancillary Functions

Syracuse University

R. F. Cotellessa and E. Bray

This effort was partially funded by the Laboratory Directors' Fund

ROME AIR DEVELOPMENT CENTER
Air Force Systems Command
Griffiss Air Force Base, NY 13441-5700

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RADC-TR-86-218, Volume I (of two) has been reviewed and is approved for publication.

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19 ABSTRACT (Continue on reverse if necessary and identify by block number)

The Northeast Artificial Intelligence Consortium (NAIC) was created by the USAF Electronic Systems Command, Rome Air Development Center, and the Office of Scientific Research. Its purpose is to conduct pertinent research in artificial intelligence, to encourage expansion in the number of faculty members and graduating students in this field, to make graduate educational programs available in an area centered in Rome, N.Y., and to expand university facilities to conduct appropriate research. The purpose of this report is to describe progress that has been made in the first year of the existence of the NAIC in developing and performing activities ancillary to the technical research tasks being carried out at NAIC member universities.

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1 INTRODUCTION

1.1 The Northeast Artificial Intelligence Consortium

The Northeast Artificial Intelligence Consortium (NAIC) is a group of eight institutions of higher learning organized for the purpose of developing research and education in artificial intelligence (AI). The participating institutions are:

State University of New York at Buffalo, Buffalo, New York

Clarkson University, Potsdam, New York

Colgate University, Hamilton, New York

The University of Massachusetts at Amherst, Amherst, Massachusetts

Rensselaer Polytechnic Institute, Troy, New York

The University of Rochester, Rochester, New York

Rochester Institute of Technology, Rochester, New York

Syracuse University, Syracuse, New York.

1.2 Objectives of the Consortium

The eight consortium institutions represent both public and private schools, varying greatly in size and academic thrust. They are also widely separated geographically. Therefore during the first year of the contract, much work has been done to put in place a management structure; to articulate both the technical tasks of the individual institutions and the ancillary goals of the consortium and to begin working towards these objectives; and to foster cooperation between the faculties of the consortium institutions.

Researchers at each institution have their own expertise and interests and are addressing a varied group of problems in AI that are of interest to the Air Force. Each of these problems has been viewed as a more or less distinct task and as such each research group submitted to the consortium a complete report covering the research task(s) undertaken at its institution during the last year. Summaries of their work are included in section 3 of this volume of the annual report and details are in Volume II.

The topics under study and the principal investigators (P.I.'s) at each institution are:

A) VMES: A NETWORK-BASED VERSATILE MAINTENANCE EXPERT SYSTEM
P.I.'s: Stuart C. Shapiro and Sargur N. Srihari
Department of Computer Science
State University of New York at Buffalo
Buffalo, NY 14260

B) DISTRIBUTED PROBLEM SOLVING

P.I.'s: Susan E. Conry, Robert A Meyer
Electrical and Computer Engineering
Clarkson University
Potsdam, NY 13676
and
Janice E. Searleman
Mathematics and Computer Science
Clarkson University
Potsdam, NY 13676

C) PLANNER SYSTEM FOR THE APPLICATION OF INDICATIONS AND WARNING

P.I.: Sergei Nirenburg
Computer Science Department
Colgate University
Hamilton, NY 13346

D) PLAN RECOGNITION, KNOWLEDGE ACQUISITION AND EXPLANATION IN AN INTELLIGENT INTERFACE

P.I.'s: Victor Lesser, W. Bruce Croft and Beverly Woolf
Department of Computer and Information Science
The University of Massachusetts
Amherst, MA 01003

E) AUTOMATIC PHOTO INTERPRETATION

P.I.'s: J. W. Modestino and G. Nagy
Electrical, Computer and Systems Engineering Department
Rensselaer Polytechnic Institute
Troy, NY 12180-3590

F) TIME-ORIENTED PROBLEM SOLVING

P.I.: James F. Allen
Computer Science Department
The University of Rochester
Rochester, NY 14627

G) SPEECH UNDERSTANDING RESEARCH

P.I.'s: Harvey Rhody
RIT Research Corporation
Rochester, NY 14623
and
John A. Biles
Computer Science Department
Rochester Institute of Technology
Rochester, NY 14623

H 1) COMPUTER ARCHITECTURES FOR VERY LARGE KNOWLEDGE BASES

P.I.: P. Bruce Berra
Electrical and Computer Engineering
Syracuse University
Syracuse, NY 13210

2) KNOWLEDGE BASE MAINTENANCE USING LOGIC PROGRAMMING METHODOLOGIES

P.I.: Kenneth A. Bowen
School of Computer and Information Science
Syracuse University
Syracuse, NY 13210

The technical tasks were unique to each participating institution, but the ancillary goals were commonly agreed upon, although their fruition would vary from institution to institution. The prime ancillary goal was to develop more AI expertise at the university level while at the same time enhancing external recognition of the consortium and its members. This would be accomplished in part by expanding faculties, increasing the number of graduate students and AI courses, and improving facilities. And also by pursuing the other consortium objectives of encouraging and supporting industrial participation in AI, expanding funding support and in general developing an active AI community. Some things like recruiting more faculty and graduate students, improving facilities, and fostering working relationship with industry, were largely institution dependent. But the consortium could be, and would prove to be, of great help by propagating the name and image of both the consortium and its individual members, by fostering interaction between the member institutions, submitting proposals for equipment on behalf of the entire consortium, and sponsoring workshops and symposia; thus making it easier for each member institution to accomplish its independent goals and tasks. Progress in one area almost always leads to progress in another, as the steps to the prime objective of more AI expertise are not straight and well defined but winding and intertwined.

It should be noted that much of the information regarding the ancillary goals of the consortium presented in this report has been derived from a questionnaire sent to each of the member institutions by the program manager, Robert Cotellessa, asking them to summarize AI related activities on their campuses. Because of varying interpretations of the questions and the depth of their answers, as well as the uniqueness of their starting positions, and fractional faculty participation comparisons between the institutions are not necessarily justifiable.

2 MANAGEMENT STRUCTURE

Management was worked out as the result of discussions during visits to the various institutions by Robert Cotellessa.

2.1 Inter-school

A) Project Director: Bradley J. Strait

B) Program Manager: Robert Cotellessa

C) Administrative Assistant: Andrea Pflug

D) Committees:
   a) Educational and Equipment Acquisition
   b) Networking

The Project Director is the responsible individual named in the prime contract with Syracuse University and maintains liaison with other administrative offices at that university. Syracuse has subcontracted with the seven other universities in the NAIC. The Program Manager is responsible for the operational activities of the NAIC and the Administrative Assistant works primarily with the Program Manager and interfaces with the Project Director. The Project Director and Program Manager have maintained a close working relationship and often have participated jointly in NAIC activities and in acting as liaison with RADC. The Program Manager's responsibilities include the preparation of reports, organization of NAIC meetings, briefings at consortium and university locations, establishment of committees and advisory boards, facilitation of networking arrangements, arrangements for vendor presentations, organization of educational efforts and seminars in Rome, N. Y., assistance in constructing a master's degree curriculum that emphasizes AI, and making preparations for creating a legal entity.

2.2 Intra-school

The Principal Investigator(s) (P.I.) at each institution is responsible for both the technical and ancillary functions at the respective institution. The P.I.'s are as follows:

Stuart C. Shapiro and Sargur N. Srihari
State University of New York at Buffalo (SUNY/Buffalo)

Susan E. Conry, Robert A. Meyer and Janice E. Searleman
Clarkson University

Sergei Nirenburg
Colgate University

Victor Lesser, W. Bruce Croft and Beverly Woolf
The University of Massachusetts at Amherst (UMass)

James W. Modestino and George Nagy (originally Herbert Freeman)
Rensselaer Polytechnic Institute (RPI)

James F. Allen
The University of Rochester (UofR)

Harvey Rhody and John Biles
Rochester Institute of Technology (RIT)

P. Bruce Berra and Kenneth A. Bowen
Syracuse University

2.3 Legal Entity

Draft copies of a charter and bylaws for establishing a non-profit corporation have been prepared and have been discussed with representatives of most of the NAIC universities. No objections have been raised in principle, as many of the universities have participated in the establishment of similar entities. However, additional effort is required to incorporate requirements peculiar to two different states and to confirm the need and desirability for forming such a corporation.

3 TECHNICAL TASK(S) of the INDIVIDUAL CONSORTIUM MEMBERS

Detailed descriptions of research tasks under investigation at each of the member institutions of the consortium are to be found in Volume II. Short descriptions of the current year's research at each institution and their plans for the next year follow.

3.1 VMES: A Network-based Versatile Maintenance Expert System

State University of New York at Buffalo

In the development of a versatile maintenance expert system for trouble-shooting digital circuits, a diagnosis system that has successfully pinpointed the faulty part of a multiplier/adder board has been implemented. An important aspect of the research is to find a good knowledge-representation scheme to support the diagnosis and the construction of a versatile maintenance system. Version 2 of the implementation has been used successfully.

See Volume II, section 2 for details.

Future plans include:

A) Device modeling and fault diagnosis of VMES:

Modification of the device representatior scheme so that it can handle a mixture of digital and analog circuitries.

B) Graphical Interfaces of VMES:

The investigation of the knowledge representation scheme for display puposes.

3.2 Distributed Problem Solving

Clarkson University

The major effort has been directed towards a formulation of the scope of the problem to be addressed by the testbed. Specific accomplishments can be noted in four areas:

A) A top level design for the architecture of a distributed testbed has been specified.

B) A specification has been developed for knowledge representation.

C) The development of software to aid the user in constructing an instance of a communication system knowledge base.

D) Problem solving strategies have been identified for specialized tasks within each agent.

See Volume II, section 3 for details.

In the coming year, activity is expected to focus on two primary areas:

A) Devlopment of specialist agents for major subtasks;

B) Development of a network simulator to provide realistic data for test purposes.

3.3 Planner System for the Application of Indications and Warning
Colgate University

During the past year, the specifications of the task have evolved from the direction of intelligent database management toward an emphasis on the problem-solving activity. The project has been two-pronged:

A) Design of a system that will:
a) Obtain as input messages concerning events in a model of a real-life subworld;
b) 'Understand' these events by detecting into which plans they fit and, whenever applicable, what goals are pursued by the instigators of the events;
c) Produce (suggestions for possible) plans of action necessary in connection with the situation in the world.

B) Implementation of this system for the world of Indications and Warning (I & W) application.

Work has concentrated on designing the mechanism and knowledge bases for the problems of plan recognition and plan production. A concentrical approach to the task was undertaken; in other words, it was decided to produce an implementation for every design version of our system, known as POPLAR. Two versions of POPLAR were developed over the past year. Goals have also been set for the implementation of the next version of the system to be known as POPLAR 3.0.

See Volume II, section 4 for details.

Work will continue on the implementation of POPLAR 3.0. This version will introduce substantial changes in the overall design of the system that will enhance the study of the problem of knowledge-based automatic planning systems.

3.4 Plan Recognition, Knowledge Acquisition and Explanation in an Intelligent Interface

The University of Massachusetts at Amherst

The research effort has two complementary goals:

A) The development of a planner, plan organizer, and associated database;

B) The development of intelligent interface tools to increase a user's ability to interact with the system.

The following achievements have been made:

A) Plan Recognition:
a) Extended and implemented a plan recognition formalism to deal with a semantic database.
b) Implemented a sophisicated focus of control mechanism that permits non-procedural specification of domain-specific focusing heuristics.
c) Developed a monitor for task specification that permits non-procedural specification of tools.
d) Developed a graphic interface that allows the creation, modification and saving of procedural specifications to be done graphically.

B) Interface Tools:
a) Implemented a natural language parser that interprets questions about tasks and procedures in the database.
b) Implemented an example-based on-line help system that provides customized examples in response to a user's request for help.

See Volume II, section 5 for details.

Work next year will be carried on in the following areas:

A) Plan recognition/planning:
a) Extension of the focus control mechanism;
b) Inclusion of the implemented monitor in the POISE system.

B) Interface tools:
a) This year's work on a special parsing routine for noun phrase processing that interacts with memory will be integrated into the general parsing effort.
b) In the field of example generation, the goals are to:
1. Move example generation to the new RADC database.
2. Develop interactive tools by which a user can use examples to explore concepts.
3. Use more sophisticated modeling of the user to generate more appropriate examples.

C) Work will continue with ThinkerToy.

D) In the field of discourse analysis, the goal is to design a system that makes discourse choices.

3.3 Automatic Photo Interpretation
Rensselaer Polytechnic Institute

The objective of this project is to develop an expert system to:

1) Assist a photointerpreter to understand, interpret, and report the contents of a (digitized) photograph more rapidly and more consistently,

2) Reduce the degree of personnel expertise required.

Two subprojects were completed and the final reports for these projects, "Design of an Inference Engine for an Image Interpretation Expert System" and "Transformation Invariant Attributes for Digitized Object Outlines", are included as attachments to Volume II section 6.

Briefly, the first project dealt with the application of Fourier and moment-invariant features to aircraft silhouettes. The results show that such relatively simple techniques are insufficient for reliable discrimination and that techniques for the determination of the silhouettes themselves must be studied further. In the second project a simple inference engine was developed. On the basis of these results, it was decided to use more powerful, commercially available expert-system development tools. Major research and development tasks currently being undertaken are:

A) Probabilistic model of images based on neighborhood-induced random fields.

B) Model for topographic terrain features.

C) Target detection and classification based upon multiple sensor inputs.

D) Symbolic image processing.

E) Relational database system for images.

F) Constrained-segmentation and labeling techniques.

See Volume II, section 6 for details.

The sub-goals of research on fundamental problems that must be solved to achieve success in automating photointerpretation tasks and the development and adaptation of mathematical and software tools to build a demonstration system that have been set up will be vigorously pursued. At this time the various tasks are to be independent of each other, in order to draw on the current skills of the participants even as new skills are being acquired. This should allow for simultaneous progress in all areas. These diverse endeavors will be gradually integrated by the principal investigators to demonstrate both significant research contribution and a prototype photointerpretation system.

3.4 Vision Oriented Problem Solving
The University of Rochester

Progress has been made in several areas:

A) Concise interval-based theory of time:

A new theory based on temporal intervals that is simpler and more elegant than previous theories.

B) Planning in uncertain worlds:

A model for problem solving in temporally rich, uncertain worlds based on the combination of temporal logic and existing logics of counterfactuals.

C) Theory of plan recognition:

A theory to relate planning and plan recognition in an intuitively satisfying manner.

See Volume II, section 7 for details.

The goal is to complete the formal theory of planning in uncertain worlds and to use it to guide the development of a planning system on the Symbolics that can construct plans to deal with uncertainty. Work on a general action reasoner will continue. A model of a simple world where two agents are constructing and executing plans will be developed.

3.7 Speech Understanding Research

Rochester Institute of Technology

Work has been carried on in three main areas:

A) Development of the signal processing algorithms, based on the auditory system model, which can be used to extract descriptive parameters from speech.

B) Development of a paradigm for phoneme segmentation and preliminary identification.

C) A literary search and the planning of a study of pattern-matching architecture to be carried out in FY1986.

See Volume II, section 8 for details.

Specific tasks for the next year are:

A) Development of a set of characteristic parameter relationships for each phoneme;

B) Development of a a dynamic production model based upon the dynamic articulator target model for the speech process;

C) Development of a speech phoneme segmentation algorithm;

D) Development of a phoneme-phoneme psycho-distance measure;

E) Examination of candidate database structures and search algorithms for

...namic phoneme identification;

C) Examination of system control structures for the integration of multi-level knowledge bases.

3.8.1 Computer Architectures for Very Large Knowledge Bases
Syracuse University

Current investigations have focused on two related areas:

A) The development of techniques for accessing the extensional database (EDB) of facts in minimum time. The problem becomes one of partial match retrieval with some form of indexing over all argument positions.

B) The development of parallel computer architectures that can further speed up EDB processing.

See Volume II, section 9 for details.

Work on partial match retrieval methods and special computer architectures for their efficient implementation all in the context of logic programming will continue. The design of the special purpose processor should begin about mid 1986. The assemblage of the necessary hardware, software and knowledge for the knowledge base back end system will begin. In addition, the investigation of the use of optical storage devices will continue.

3.8.2 Knowledge Base Maintenance Using Logic Programming Methodologies
Syracuse University

Principal efforts have been the exploration and development of a class of extensions of Prolog, called metalevel extensions, which meet the following requirements:

A) The extension allows one to express alternative and changing knowledge bases;

B) The extension has a logical basis;

C) The implementation methodology for Prolog can be extended to efficiently implement the metalevel extensions.

See Volume II, section 9 for details.

The immediate goals are the coding of the extended Warren abstract machine (WAM) and the installation of the accompanying changes to the compiler. When this is achieved, there will be an extended period of implementation of prototypical knowledge-base maintenance schemes and expert systems. Finally, work will begin to integrate the code management schemes of WAM with the software being designed for the low-level management of very large knowledge bases by Professor P. Bruce Berra's group working on Computer Architecture for Very Large Knowledge Bases.

4 ANCILLARY GOALS OF THE CONSORTIUM

The ancillary goals of the consortium were three-fold: to develop more artificial intelligence expertise at the university level; to encourage industrial support of and participation in the AI programs of the consortium institutions and interaction with institutions outside the consortium; and to develop active AI community support.

4.1 Develop More AI Expertise at the University Level

4.1.1 Faculty and graduate student growth

While difficult, systematic and aggressive efforts are being made at each of the member institutions to add new faculty members, post-doctoral students and US graduate students specializing in AI. Some progress has been made and, in addition because of the consortium, there is an increased awareness of an interest in AI research on the various campuses. This alone has resulted in an increase in the number of faculty and graduate students working on AI research.

All institutions report that they have increased the total number of graduate and post-doctoral (where applicable) students in their AI research programs, including an increase in the number of US students. Some of these are supported by funding other than this consortium contract. To attract more US students, some of the institutions have indicated a willingness to grant exceptions to their rules regarding the maximum number of credits a student can transfer from one institution to another. Several consortium institutions are working with various industries to secure increased funding for graduate fellowships.

In total, the consortium members report a gain of 11 new faculty members and an increase of equal size in the number of present faculty members now engaged in AI research. Forty master's degrees and six Ph.D. degrees were granted by the individual member institutions. Of the eight participating institutions it should be noted that Colgate has only an undergraduate program, offering no advanced degrees and that RIT has no Ph.D. program.

As progress is made in other areas and the consortium continues to be better known, the task of recruiting should become somewhat easier.

4.1.2 Facility improvement

The consortium has been of great benefit to the member institutions in attaining the goal of facilities improvement. In addition to acquisitions and improvements that can be directly attributed to the contract, several institutions report that because they have become better known, industry and computer companies are more willing to cooperate, to make contributions or loans of equipment, and to give generous discounts. Also proposals submitted jointly by the members of the consortium greatly enhance the likelihood of their being accepted for funding.

In answer to a request for information about equipment and facilities that have been added to facilitate AI research in the first year of the contract, the

various institutions responded as follows (the source of funding is noted when indicated by the institution):

Buffalo:
1 SUN-2 Workstation (NSF equipment grant and State funds)
2 SUN-3 Workstations, 1 with Data Cube Image processor
1 Symbolics 3670
2 Symbolics 3640, 1 with color monitor and CAD buffer
1 TI Explorer
1 TI portable PC (loan from TI)
1 Eikonix Camera

Clarkson:
AI Laboratory created
Symbolics 3670 Lisp machine
TI Computer
Software tools: Prolog
TOPSI
Scheme
TI Personal Consultant

Colgate:
Symbolics 3600 Lisp machine (acquired with the help of RADC and PAR Technology)
Vax 11/750 (NSF grant)

UMass:
21 Lisp machines including 3 Symbolics 3600 processors and 10 TI Explorers

RIT:
15 Dandelion stations with support facilities (Xerox grant)
RuleMaster expert system shell (Radian Corp. grant)
TI Business Pro with software

UofR:
3 LISP machines
12 Dandelions
12 Suns
BBN Butterfly Parallel Processor

RPI:
2 Sun Workstations
3 PC-AT's
Network controller
Imagen laser printer
Image digitizer
Unix upgrade of PDP-11/40

Syracuse:
Vax 11/780
TI Business Pro Computer with Personal Consultant
Expert System Shell (machine thru CASE, software NAIC)

Although much progress has been made in facilities, the need for an electronic/computer network that will link the geographically separated consortium members remains a concern. An application is being filed that would make MILNET available at each of the institutions.

Also needed is equipment common to each institution so that educational software developed at one institution can be easily used by another without extensive reprogramming. Toward this end a committee was formed at The Northeast

Artificial Intelligence Consortium Workshop, held at the Syracuse University Minnowbrook Conference Center in Blue Mountain Lake, New York in July 1985. Their task was to complete a prospectus for use in seeking industrial support in the acquisition of equipment. The committee consisted of Susan Conry, Chairman; Victor Lesser, Stuart Shapiro, Harvey Rhody, John Biles, John Oldfield, and Allan Tucker. They have drafted two proposals on behalf of the NAIC. One, submitted to the DoD Instrumentation Program, is intended to acquire enough machines so that each institution will be similarly equipped and the exchange of software will be facilitated. A second proposal has been drafted also with the purpose of obtaining machines suitable for the development and exchange of educational software.

The results of the DoD proposal should be known in April. A copy of this proposal is attached as appendix A.

4.1.3 Seminars, course changes and additions:

Hand in hand with increased faculty and improved facilities go course changes and additions and with course additions, come more students and again the need for more faculty and facilities. This process is well under way at an increasingly rapid pace. Although in the aforementioned questionnaire, the consortium members were not asked specifically to list new AI courses at their institutions, the following information was given in answer to a question about overall improvements:

Buffalo: Knowledge Representation - advanced graduate level
Expert Systems (to be introduced) - graduate level

Clarkson: Expert Systems - graduate/senior level
Symbolic Computation - senior/ junior

UMass: AI course offerings revamped and expanded

RIT: Graduate program concentration in AI
Expert Systems and Natural Language Processing courses
New funding for thesis projects
Seminar on Syntactic Pattern Recognition (to become a course)

RPI: Engineering Design Applications of Expert Systems
A revised AI course
Graduate Knowledge-Engineering Program

All member universities have improved or expanded their AI course offerings.

Graduate seminars on AI have become regularly scheduled functions on campuses where they had not previously existed and more frequent on those where they had been previously held. Plans have been made by Buffalo University and the University of Rochester for joint seminars to be held in the spring and summer of 86. In addition, workshops and colloquia for an individual institution have featured experts from another consortium institution.

As a result of a request initiated by Dr. Bowen of Syracuse University, and

with the support of RADC, the Air Force European Office of Aerospace Research and Development, as a part of their Window on Science program, arranged for Mr. Jaakov Levy of the Weizmann Institute in Israel to present seminars on logic programming and Concurrent PROLOG at several consortium institutions. Mr. Levy visited RADC, Syracuse University, University of Massachusetts, Colgate University, Clarkson University and SUNY at Buffalo.

4.1.4 Interaction between members of the consortium:

Interaction between members of the consortium has taken place on several levels. The most obvious and perhaps most influential at the beginning in bringing together the diverse faculties were the consortium meetings. They served both to disseminate technical information and coalesce the participating institutions into a consortium. Later monthly status reports which also served as newsletters, cross visits of a more specific nature, and exchanges of research and personnel became important. In addition, the attendance at various national and international professional conferences offered P.I.s further opportunities to confer and, maybe even more importantly, to promote the consortium and its image. Details of these meetings will be covered later in section 4.2.4 entitled "National and International Conferences and Publications."

The following meetings took place before the formal organization of the consortium and were instrumental in the formation of the consortium:

July 29-31, 1984 Post-Doc AI Workshop at Minnowbrook Conference Center, Blue Mountain Lake, New York

Nov. 7, 1984 AIC CEO Interface Meeting at RADC, Griffiss AFB, New York

Nov. 30, 1984 Research Exchange Meeting at Colgate University

Two consortium meetings have been held and three more are planned, one to be held in the spring at UMass, one in the summer sponsored by the University of Rochester, and one in the fall at SUNY/Buffalo.

A) Minnowbrook July 15-18, 1985

The Northeast Artificial Intelligence Consortium Workshop was held at the Syracuse University Minnowbrook Conference Center in Blue Mountain Lake, New York. One day was devoted to research, educational and facilities improvement discussions, involving only the participants from the consortium institutions. Meetings of the Education Committee and of the Industrial Advisory Board (see section 4.2.3) were also held. Presentations were made by representatives of several goverment agencies.

The following decisions were made:

1. There should be three meetings of the consortium yearly. These meetings should be primarily technical in nature. Plans for 1986 called for one to be held at Colgate in October, with the other two planned for spring and summer. Dates for the summer meeting are July 9-11, 1986.

2. The need for equipment, common to all consortium institutions, to facilitate software development and exchange was identified. A committee was formed to complete a prospectus for use in seeking industrial support in the acquisition of such equipment. The committee consisted of Susan Conry, Chairman; Victor Lesser, Stuart Shapiro, Harvey Rhody, John Biles, John Oldfield, and Allan Tucker. They met at Minnowbrook, again in August (at IJCAI), and in September (at UMass). Two proposals have been drafted by this committee and have already been discussed in some detail in section 4.1.2, entitled "Facility Improvement".

3. The concept of the RADC Seminar Series was formulated. The seminars are intended to be tutorial as well as informational, i.e. reports of current research.

4. Two brochures are to be distributed, the first providing information on graduate educational opportunities at the consortium institutions and the second featuring the active AI research at each institution. The research brochure has been completed. Present plans, however, are to combine the two types of brochures into one brochure for future publication.

5. A NAIC Technical Report Series should be initiated. Work continues on this project.

6. A curriculum for a master's degree program that emphasizes AI should be developed. Additional comments about this program are to be found in section 4.3.2.

7. Greater research cooperation should be encouraged. Considerable progress has been made toward this goal and is covered in Vol II, Section 3, entitled "Major Areas of Interaction". Success along these lines is due in no small part to the workshop at Minnowbrook which began as a meeting of eight separate and distinct institutions and ended as a meeting of a consortium.

B) Colgate October 17-18, 1985

The fall meeting of NAIC at Colgate University was a technical meeting, on the subject of Natural Language Research. A short evening meeting was devoted to routine administrative matters and future plans. This format, with the prime emphasis on the exchange of technical information, was agreed upon at the Minnowbrook meeting in July.

A formal means of communication between members of the consortium and with the staff at RADC is the distribution of the monthly status report. Each institution submits a monthly status report. A summary of this information is compiled and brief explanations of consortium-wide and related activities are written by the project manager. This document, along with copies of each institution's status report, is then distributed to all consortium members and to staff members at RADC. From time to time, copies of technical reports are also distributed as attachments to this monthly newsletter for the benefit of

the P.I.'s and RADC staff members.

Information and expertise is also shared on a one to one level among members of the consortium. There have been a sabbatical exchange (two more planned), some sharing of software and many cross visits, including both informal talks and demonstrations and more formal workshop or colloquium presentations. Examples of this type of exchange listed below represent a few of such exchanges.

Buffalo: Copies of SNePS sent to Colgate and Clarkson

Clarkson: UMass summer and fall Sabbaticals for Drs. Meyer and Conry (1986)

Colgate: UMass Sabbatical for Dr. Nirenburg (1985)

RIT: Cross registration with UofR.

During the year as the researchers have become better informed about the work being done by other members of the consortium, it has become evident that whereas initially the various problems were viewed as distinct tasks with little or no overlap, this is not wholly the case. Researchers have come to realize that work, if not directly, at least indirectly related to theirs is being conducted at other sites. The major areas of interaction are:

A) Planning and Plan Recognition
University of Massachusetts, Colgate University and University of Rochester

Researchers at the University of Massachusetts, Colgate University, and the University of Rochester have discovered that they are all interested in planning problems. Professors Lesser (at the University of Massachusetts) and Nirenburg (at Colgate University) have been collaborating on one group of planning problems, while Professor Lesser has been discussing other types of planning and plan recognition issues with Professor Allen (at the University of Rochester).

Professor Allen has been investigating formal aspects of planning. His work seeks a somewhat formal characterization that can be useful in temporally rich models. The goal is to generalize in such a manner that plan recognition can treat situations in which plans are not simply sequences of actions, but have temporal structure as well. Professor Lesser has been working at the level of specific planning systems. His plan recognition system uses a built-in hierarchy of plans, with focus of control, constraining where in the hierarchy the system tries to look in recognizing a plan. Professor Lesser's system does treat some degree of concurrency. The two researchers are exploring issues related to the handling of concurrency and temporally rich models.

Professor Nirenburg spent a sabbatical year at the University of Massachusetts during academic year 1984-1985. At that time, he and Professor Lesser worked together intensely on problems associated with high level plan recognition. Their focus at that time was one of determining how

to elicit the high level information needed to do plan recognition. The work involves investigation of planning from "first principles", introducing a mixed strategy for planning. Their strategy would make use of "canned" plans for standard situations and planning from "first principles" for non-standard ones. Professors Lesser and Nirenburg are also studying ways of combining plan recognition and planning in one system.

B) Natural Language
University of Massachusetts, Colgate University and
University of Rochester

The natural language group at the University of Massachusetts is currently making a direct contribution to Professor Nirenburg's work on machine translation. One of their students is engaged in the design and implementation of a blackboard based architecture for the source language analysis stage in a system for knowledge based machine translation of natural language. This will result in a speech level parser that will interface with Professor Nirenburg's translator.

Natural language is another area of mutual interest at the University of Massachusetts and the University of Rochester. Professor Woolf and the group at the University of Massachusetts investigate natural language generation and recognition in a framework that employs a grammatical model for discourse structure. Professor Allen and the group at the University of Rochester use an embedded model of discourse action. Their system uses plan reasoning to put discourse together. Natural language generation and recognition are related to the problems of planning and plan recognition in their system. It seems to handle novel situations better than the system built at the University of Massachusetts. On the other hand, the system built at Rochester does not handle situations in which things go "as expected" as well as the one at UMass. There has been dialog among researchers at the two institutions regarding development of research leading to discovery of reasons why this should be so.

C) Cooperation Paradigms
University of Massachusetts and Clarkson University

Professors Meyer and Conry at Clarkson are investigating cooperation paradigms in the context of a large communication system. Professor Lesser at the University of Massachusetts is investigating the same issues in the context of a distributed vehicle monitoring system. Each group has recognized that the two application domains share some common features, yet are sufficintly different as to make the problems encountered distinct ones. Each group also believes that not enough research on distributed problem solving has yet been done that the fundamental principles underlying coherent system behavior can be characterized. Professors Meyer and Conry will be spending the fall semester of 1986-1987 at the University of Massachusetts. One of the goals of this sabbatical visit is to facilitate an intense investigation of the universal features of distributed problem solving paradigms. The basic question to be addressed is: how much of what is appropriate in one domain is also appropriate in another. Professors Meyer and Conry are currently developing software applicable to the domain

of communication systems. Professor Lesser has extensive software already developed. It is the belief of each group that the research of the other complements its own work, and that continued strong interaction is beneficial to both research efforts.

D) Emulated Distributed Environment
University of Massachusetts and Clarkson University

Professor Conry and her students at Clarkson have been working on mechanisms for automatically distributing LISP functions when they are implemented on multiprocessor systems. A simulator has been written and results to date appear to be promising. The only difficulty with the research to date has been the fact that a simulated environment has been necessary. As a result, some analysis of a worst case scenario has been required to ensure that all potential barriers to "safe" parallel execution are detected. These barriers would be easy to detect in a multiprocessor environment or in an emulated parallel environment. Dr. Corkill at the University of Massachusetts and his group are currently working on an emulator for a distributed environment. Professor Conry and Dr. Corkill believe that the emulated environment would be an ideal vehicle for experimentation with strategies of the kind that have been proposed.

E) Narrative Models
SUNY Buffalo and University of Rochester

Professor Shapiro and his students at SUNY Buffalo are working on problems associated with understanding narrative. One of the approaches they have taken involves investigation of the temporal structure of narrative. In this work, they make use of temporal frames and use them in reasoning about the narrative. This model of narrative embodies temporal structure similar to that being investigated by Professor Allen (at the University of Rochester). Professor Allen's work is primarily directed at the development of theoretically significant results that can be demonstrated with small prototype systems. Some of the knowledge representation schemes developed by Professor Shapiro and his students have been employed in Professor Allen's systems. Professor Shapiro uses SnePs, his semantic net processing system, to process the structures under investigation. The two groups continue to be in contact.

F) Shallow Versus Deep Reasoning
SUNY Buffalo and Clarkson University

Professor Srihari and his students at SUNY Buffalo are investigating the role of shallow versus deep reasoning in diagnostic systems. They have been viewing the problem in the context of neurological diagnosis systems, but they are currently directing their attention to other domains, such as electronic maintenance. One of the major subtasks in system control problems for large communication systems is a function involving fault diagnosis and isolation. Professors Meyer and Conry feel that this diagnosis problem is one which will probably be most amenable to a problem solving paradigm that combines shallow and deep reasoning. It is exactly

this type of paradigm that Professor Srihari has been investigating. The potential for mutually beneficial cooperation in this area has been recognized, and initial exchange of ideas has occurred. It is anticipated that this interaction will grow.

4.2 Encourage Industrial Support and Participation and Interaction with Institutions Outside the Consortium

Efforts to encourage industrial support of and participation in the AI research at the various institutions has been made by both the consortium's program manager and project director and the individual institutions. The consortium has been well received and the individual institutions report that being a member of the consortium has resulted in a growth of interest and opportunities for interaction with industry.

4.2.1 Interaction on the consortium level

Beginning in April 1985, the program manager and/or the project director made visits to General Electric, Sperry Corporation, Kaman Sciences, PAR Technologies, and IITRI to describe the consortium, learn about AI programs already under way at the industry level and to discuss industrial coupling. The formation of an Industrial Advisory Board resulted from these visits (see below, Section 4.2.2).

As a result of the talks with the Sperry Corporation, representatives from each of the consortium institutions were invited to a meeting in Princeton, NJ (May 2-3, 1985). Representatives from their Knowledge Systems Center in Bloomington, MN and Corporate Technology Center in Reston, VA presented overviews of their current research and demonstrated the Texas Instruments Explorer Workstation with Intellicorp's software, Knowledge Engineering Environment (KEE). This meeting led to further meetings and visits on behalf of the consortium collectively and by individual institutions. At the July consortium meeting in Minnowbrook, Sperry put forth a proposal for a comprehensive relationship among the Sperry Corporation, the CASE Center at Syracuse University and the consortium, to be known as the Sperry Interface Project. As stated then, the goal of the project is to foster a relationship that will enhance such areas as educational support, joint research ventures and hardware technology. An Administrative Committee was formed which met in Syracuse later in July. Subsequently the Sperry Corporation donated to CASE and NAIC jointly, a TI Explorer with KEE software and four Sperry faculty fellowships are expected to be implemented in the fall of 1986.

4.2.2 Industrial Advisory Board

During visits to various companies by the project director and/or the program manager to investigate the possibilities of industrial coupling, several individuals expressed an interest in serving on an industrial advisory board. The board was formally organized in June 1985, with twelve members, and held its first meeting at Syracuse University on June 26th. The purpose is to seek the advice and counsel of the board in establishing interactions between industry

and the consortium in pursuing research, educational and facility development activities. The board met again as a part of the consortium's Minnowbrook Workshop in July and presented a report. Their primary focus was on educational matters.

The industrial advisory board consists of the following members:

Dr. Larry Alexander	General Electric Company
Mr. William Bennett	SINGER Aerospace and Marine Systems
Dr. Gerard Capraro	Kaman Sciences Corporation
Dr. James Cook	IIT Research Institute
Dr. Patrick Corbin	Sperry Corporation
Mr. Eugene P. Damm, Jr.	IBM Corporation
Mr. George Hunt	Xerox Corporation
Mr. Robert Kleeman	Symbolics, Inc.
Dr. James Mosko	ITT Defense Comunications
Mr. Charles Saylor	Niagara Mohawk Power Corporation
Dr. Dan Simmons	United Technologies Corporation
Dr. Benjamin Snavely	Eastman Kodak Company
Dr. Michael J. Zoracki	PAR Technology

4.2.3 Interactions by individual consortium institutions

All consortium institutions report exchanges of information with industries involved in AI research. Some have resulted in the establishment of relationships between the institution and a given company. Some consortium members have also presented papers at other institutions of higher learning outside the consortium. Attendance at various international and national conferences has also afforded opportunities for interaction with institutions outside the consortium (see section 4.2.4).

Specific examples if the interactions described above are listed below:

Buffalo: Advising Xerox Webster Research Center
Demonstrations for Texas Instrument (TI) and McDonnell Douglas
Chosen as a beta test site for Scheme by TI

Clarkson: Invited talks at IBM, General Electric, and GTE Research Labs
Visit to Lincoln Labs resulting in a consulting agreement
Chosen as a beta test site for Scheme by TI

Colgate: Increased cooperation with PAR Technology
Talks at Boston University, Brandeis University, SUNY at Stony Brook, and CUNY at Queens

UMass: Visit by McDonnell Douglas
Workshop for Texas Instruments
Chosen as a beta test site for Scheme by TI
Bruce Croft on sabbatical leave in Ireland, endowed chair in AI

RIT: Research and development contract with Sybron Corp. and with Data Collection Services, Inc.

An association with the Speech Recognition Systems, Inc of Rochester, New York had led to the acquisition of speech processing software
Chosen as an evaluation site for Scheme by TI

UofR: Increased cooperation with Kodak

RPI: Talks at BYU, U. of Nebraska, IBM, PAR Technology and General Electric
Seminar at Bell Labs

Syracuse: Papers at U. of Florida, Naval Research Labs, Digital Equipment Corp., U. of Minnesota, General Electric, U. of California at Berkeley, SDC Corp., Ohio State, and Army Materials and Mechanics Research Center
Presentations at Tokyo U., Mitsubishi Electric Corp., Tojiba Corp., Nippon Telegraph and Telephone Corp, MITI Electrochemical Laboratories
Presentation at Pacific Computer Communications Symposium in Seoul, Korea
Visits to Optical Data Inc. and Logicon

Five of the eight institutions indicated on the aforementioned questionnaire that they had received new grants or contracts as a result of their consortium affiliation. Proposals have been submitted by others and more proposals are being prepared.

4.2.4 National and international professional conferences and publications

Consortium P.I.'s deem attendance at national and international professional conferences to be of great importance for several reasons. First the consortium gains a higher degree of visibility by having several consortium institutions present at such meetings. This is in addition to the growing respect afforded the consortium by the presentation of papers and the chairing of sessions. Secondly, the meetings afford yet another opportunity for interaction between consortium P.I.'s which is most helpful. The following are the major conferences, attended by consortium P.I.s as presenters and attendees, and mentioned in monthly status reports (funding for attendance was not necessarily provided by this contract):

April: Conference on Intelligent Systems, Rochester, MI

July: Assoc. for Computational Linguistics, Chicago, IL

July: International Logic Programming Symposium, Boston, MA

August: International Joint Conference on AI, Los Angeles, CA

October: Expert Systems in Government Workshop, Washington, D.C.

Many P.I.'s also attended conferences that were aimed at their specialties. These are in addition to the conferences and workshops sponsored by the consortium. Thirteen papers have been published in journals or conference

proceedings. Numerous papers have also been submitted for publication and/or presentation at various conferences here and abroad.

4.3 Develop Active AI Community Support

The goal of developing active community support was pursued in conjunction with the other goals of the consortium, especially that of encouraging industrial support and participation. One aspect was the enhancement of the consortium's image. The other was to provide a service, such as courses in AI, that might lead to the awarding of an advanced degree.

4.3.1 Enhance the consortium's image

Each visit to an industry, every paper presented at a conference helped to make the consortium more visible. Press releases to newspapers, professional society publications, various newsletters and alumni magazines, and radio and TV interviews have also enhanced the consortium image. To quote one P.I., "the consortium has put us on the AI map".

A brochure describing the research activities of each member institution was prepared. This will aid in the recruitment efforts of each institution as well as provide publicity for the consortium.

4.3.2 Public service

Courses for personnel at RADC and local industry are to be given at the Syracuse University Graduate Center at Rome, NY. A thorough study has been made of the computer science and computer engineering curricula at other institutions and it is planned to have a draft curriculum available for comment in 1986. An introductory course was offered in the spring of 1985. A second course planned for the spring of 1986 has generated enough interest that it will be necessary to provide two sections.

ACM chapter Special Interest Group (SIG) for AI (SIGART) has been established in Syracuse and it is hoped that similar groups will be started at other locations.

ARO/DoD-URIP CONTROL NO. _____
To be completed by ARO

Principal Investigator Robert F. Cotellessa

Department School of Engineering

Institution Clarkson University

Street/Bldg/Room Clarkson Hall, Room 143

City Potsdam State N.Y. ZIP 13676 Phone No. (315) 268-6446

Title of Proposal Acquisition of Multiple LISP Workstations to Facilitate Communication and Software Exchange Within the Artificial Intelligence Consortium

Instrumentation Requested 11 Dedicated LISP Workstations

Amount Requested $300,000

Reviewing Agency (Circle one or more as appropriate)

ARMY NAVY (AIR FORCE)

Amount, Source of Other Funding $123,820 from AIC Member Universities

Total Cost of Proposal $423,820

Area of Proposed Research (Give major heading/subheading as shown in Section III of DoD/URIP FY86/FY87 Announcement)

Artificial Intelligence

Current DoD Contract(s): (YES) NO
If yes, give agency, Point of Contact, Phone No. U.S. Air Force, Rome Air Development Center, Mr. Donald Gondek, (315) 330-3011

Other agencies receiving this Instrumentation Funding Request: (Circle one or more)

NSF DOE NIH (Other) None
(specify)

Name(s) and Phone Number(s) of Point(s) of Contact at other Agencies: _____

University Official authorized to obligate the institution contractually:

Name Richard J. Nunge or Catharine L. Owen

Address Division of Research, Clarkson University

Potsdam, New York 13676

Phone No. (315) 268-6479

SIGNED: Catharine L Owen

Date 11/3/85

Request for Instrumentation

Abstract

The Northeast Artificial Intelligence Consortium is a group of eight universities organized for the purpose of developing research and education in artificial intelligence. Funding for research on a number of topics in artificial intelligence has been provided to the Consortium through the Rome Air Development Center and the Air Force Office of Scientific Research. The problems being investigated at member institutions were initially distinct from one another. The research projects include investigations in logic programming and the development of special purpose hardware, temporal knowledge and its use in problem solving, speech understanding, expert maintenance systems, image understanding, distributed problem solving, natural language generation, processing, and recognition, plan recognition, and intelligent user interfaces. Over the last year, it has become evident that strong relationships are developing among these research projects. It would enhance the research greatly if code developed at one institution could be readily transported to another.

The LISP environments in use at the member institutions are not uniform. Some of the universities operate on VAX systems, others use LISP machines. Several dialects of LISP (some of them locally developed) are used within the Consortium, most institutions are currently converting to Common Lisp. For these reasons, there has been no convenient mechanism by which code developed at one institution could be transported to another.

This proposal requests instrumentation in the form of a number of LISP processors. These processors are to be housed at the Consortium member institutions and used as development tools in research. An inter-campus network of identical machines and programming environments will address the portability issue and increase the productivity of the Consortium as a body.

Texas Instruments Bids - Explorer Systems
12 November 1985

From: Frank Vanacore (516) 454-6622
1 Huntington Quadrangle, Suite 3C10
Melville, New York 11747

(9) Model XP7421 Explorer System (Part Number: 2249426-0016) with:

4 Megabytes main memory	List Price:	$64,400.00
2 140 Megabyte hard disks	Discounted Price:	$35,420.00
Ethernet Interface	Installation:	$ 300.00
	Total Requested:	$35,720.00

(2) Model XP7821 Explorer System (Part Number: 2249426-00250) with:

8 Megabytes main memory	List Price:	$75,400.00
2 140 Megabyte hard disks	Discounted Price:	$41,470.00
Ethernet Interface	Installation:	$ 300.00
	Total Requested:	$41,770.00

(8) Model XPB-110 Mass Storage Enclosure (Part Number: 2236148-00210) with:

tape backup (required for each standalone system)	List Price:	$ 4,000.00
	Discounted Price:	$ 2,200.00
	Installation:	$ 150.00
	Total Requested:	$ 2,350.00
	TOTAL PROPOSAL:	**$423,820.00**
	less Cost Sharing:	**$123,820.00**
	TOTAL REQUESTED OF DoD:	**$300,000.00**

COST SHARING

The member institutions of the Consortium have agreed to cost share to the extent of $123,820.00 should this proposal be funded with a government contribution of $300,000.00.

Research Utilizing the Instrumentation

The Northeast Artificial Intelligence Consortium is a group of eight universities organized for the purpose of developing research and education in artificial intelligence. The institutions participating in the Consortium include the State University of New York at Buffalo, Clarkson University, Colgate University, the University of Massachusetts at Amherst, Rensselaer Polytechnic Institute, the University of Rochester, Rochester Institute of Technology, and Syracuse University. Initial research funding has been provided by a five year contract through the United States Air Force, Rome Air Development Center and the Air Force Office of Scientific Research under contract F30602-85-C-0008.

The group of problems addressed at the member institutions is varied. Each institution has a group currently working on one (or more) problems in artificial intelligence that are of interest to the Air Force. Initially, these problems were viewed as distinct tasks. There seemed to be little overlap in the research being performed at different sites. Over the last year, the Consortium membership has experienced a growing sense of interdependence among institutions. Researchers at one site have realized that work related to theirs is being done at other sites. The desire to share software resources has been articulated on many occasions. The equipment acquisition proposed herein would facilitate this sharing of resources and actively encourage more extensive cooperation.

Research Currently Funded by the Department of Defense

In this section, we briefly summarize the research topics being pursued under Department of Defense sponsorship at each of the member institutions. The names of key individuals at each institution are mentioned, though their curriculum vita are not a part of this proposal (for reasons of space).

At the State University of New York at Buffalo, Professors Stuart Shapiro and Sargur Srihari are investigating the development of a versatile expert system for equipment maintenance. This intelligent system would be able to advise a human technician on troubleshooting, diagnosis, and repair aspects of equipment maintenance. It will be a rule based system, with several modes of man/machine interaction. These include interactive computer graphics, image understanding, and narrative understanding. Fundamental research issues being addressed lie in the areas of shallow versus deep reasoning in diagnostic systems and reasoning about visual knowledge.

The effort at Clarkson University lies in the area of distributed problem solving. Issues in distributed artificial intelligence are being addressed in the context of system control problems for the Defense Communications System. Large communication systems (such as the DCS) have a structure in which such tasks as performance monitoring and assessment, traffic control and routing, and fault detection and isolation can be performed by a distributed network of problem solving agents. This research is focused on cooperation and coordination problems in a network of problem solving agents which is distributed in two dimensions. The network of intelligent agents is geographically distributed. Each agent would (if deployed) reside physically

at a geographically distinct site. At each site where an intelligent agent resides, the agent is composed of a number of loosely coupled agents: one for performance monitoring and assessment, one for fault isolation, one for service restoral, etc. This means that, for example, the fault isolation agent at site X might need to coordinate its activities with its counterpart at site Y. Coordination issues arise at the level of inter-site activity and problems of representation and the degree of coupling and cooperation arise at the level of the individual site. This research is being performed in a group led by Professors Susan E. Conry and Robert A. Meyer.

Professor Sergei Nirenburg at Colgate University is engaged in the design of a knowledge representation scheme for application in the field of indication and warning. This effort includes both the theoretical design and implementation of the representation scheme. In addition, a natural language front end, a parsing system, a database management system, and a system of automatic reasoning are being implemented. The central areas of basic research being addressed have evolved somewhat in the past year, and are now concentrated on situation assessment and planning.

The goal of the effort at the University of Massachusetts at Amherst is the design of a system for monitoring the progress of complex distributed tasks, assisting in their execution, and describing previously completed tasks. The system will be designed to acquire the necessary knowledge for generating descriptions of the current state of the tasks as well as explanations of why certain actions were taken or why certain decisions were made. Led by Professors Victor Lesser, Bruce Croft, and Beverly Woolf, the project involves work in four major areas: (1) interpretation and planning,

(2) knowledge representation, (3) knowledge acquisition, and (4) natural language input and generation. Each of these areas is related to the central theme of acquiring detailed, dynamic models of user activities in distributed, tool-oriented environments and using these models to provide assistance and explanation.

Automatic photo interpretation is the focus of the research being led by Professors Modestino and Nagy at Rensselaer Polytechnic Institute. A system is being developed that would make use of knowledge based techniques to achieve image segmentation, the selection of measurements for classification, object recognition through composition, and automatic label placement on imagery of identified features.

Professor James Allen and his group at the University of Rochester are continuing research on time oriented problem solving with Department of Defense sponsorship. The effort being funded under the Consortium contract concerns the representation of temporally qualified knowledge and its use in advanced problem solving systems. Current problem solving systems are limited in their applicability by world models that are inadequate. In most systems, the model of time used requires that actions be considered instantaneous and that only one action occur at a time. The world model being developed in this research expresses in temporal logic all the planner's knowledge of the past, present, and future in relation to a particular problem. In simulating the effects of an action, the state of the world is not updated temporally. Instead, the planner's knowledge (primarily in the form of predictions about the future) is updated. The goal of the research is one of developing theories of problem solving that are sufficiently powerful to be able to

reason about interacting with external events.

At the Rochester Institute of Technology, Professors Harvey Rhody and Al Biles lead a group working in the area of speech understanding systems. These systems would use knowledge based techniques to reduce the dimensionality of speech signals while preserving the informaton required for speech recognition. Their work in the last year has been concentrated on development of a speech workstation that can be used in the development of speech understanding strategies.

Two groups at Syracuse University are involved in research sponsored under the auspices of the Consortium. One, led by Professor Kenneth Bowen, is concentrating on knowledge base maintenance. This work involves the use of logic programming methodologies in the maintenance of consistency and integrity constraints. The vehicle for the investigation lies in the development of a system called metaProlog. Expression of generic knowledge representation formalisms and generic database management functions in metaProlog as well as the construction of prototype maintenance systems written in metaProlog are central goals of the effort. The second group at Syracuse University is led by Professor P. Bruce Berra. Its work is directed towards the development of hardware and software architectures that support efficient logic programming. The goal is to devise mechanisms for exploiting inherent parallelism, eliminating processing bottlenecks, and implementing effective secondary storage organizations for logic programming systems. The application of this work lies in the development of advanced architectures for knowledge based systems.

Areas of Strong Interaction

Researchers working on the projects mentioned in the preceding section meet on a relatively frequent basis. At each such meeting, it seems that a new area of strong interaction is discovered. In this section, some of those areas are briefly described. Many of these activities have direct bearing on research funded by the Department of Defense, while others are indicative of avenues of research that would be of interest to that agency.

Researchers at the University of Massachusetts, Colgate University, and the University of Rochester have discovered that they are all interested in planning problems. Professors Lesser (at the University of Massachusetts) and Nirenburg (at Colgate University) have been collaborating on one group of planning problems, while Professor Lesser has been discussing other types of planning and plan recognition issues with Professor Allen (at the University of Rochester).

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models.

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The natural language group at the University of Massachusetts is currently making a direct contribution to Professor Nirenburg's work on machine translation. This work, though not funded by the Department of Defense, could certainly be of interest. One of the students affiliated with the natural language group at the Univeraity of Massachusetts is engaged in the design and implementation of a blackboard based architecture for the source language analysis stage in a system for knowledge based machine translation of natural language. This will result in a speech level parser that will interface with Professor Nirenburg's translator. The need for common equipment in an endeavor of this kind should be self evident.

Natural language is another area of mutual interest at the University of Massachusetts and the University of Rochester. Professor Woolf and the group at the University of Massachusetts investigate natural language generation and

recognition in a framework that employs a grammatical model for discourse structure. Professor Allen and the group at the University of Rochester use an embedded model of discourse action. Their system uses plan reasoning to put discourse together. Natural language generation and recognition are related to the problems of planning and plan recognition in their system. It seems to handle novel situations better than the system built at the University of Massachusetts. On the other hand, the system built at Rochester does not handle situations in which things go "as expected" as well as the one at UMass. There has been dislog among researchers at the two institutions regarding development of research leading to discovery of reasons why this should be so.

Professors Meyer and Conry at Clarkson are investigating cooperation paradigms in the context of a large communication system. Professor Lesser at the University of Massachusetts is investigating the same issues in the context of a distributed vehicle monitoring system. Each group has recognized that the two application domains share some common features, yet are sufficiently different as to make the problems encountered distinct ones. Each group also believes that not enough research on distributed problem solving has yet been done that the fundamental principles underlying coherent system behavior can be characterized. Professors Meyer and Conry will be spending the summer and fall of 1986 at the University of Massachusetts. One of the goals of this sabbatical visit is to facilitate an investigation of the universal features of distributed problem solving paradigms. The basic question to be addressed is: how much of what is appropriate in one domain also appropriate in another. Professors Meyer and Conry are currently developing software applicable to the domain of communication systems.

Professor Lesser has extensive software already developed. It is the belief of each group that the research of the other complements its own work, and that continued strong interaction is beneficial to both research efforts.

Professor Shapiro and his students at SUNY Buffalo are working on problems associated with understanding narrative. One of the approaches they have taken involves investigation of the temporal structure of narrative. In this work, they make use of temporal frames and use them in reasoning about the narrative. This model of narrative embodies temporal structure similar to that being investigated by Professor Allen (at the University of Rochester). Professor Allen's work is primarily directed at the development of theoretically significant results that can be demonstrated with small prototype systems. Some of the knowledge representation schemes developed by Professor Shapiro and his students have been employed in Professor Allen's systems. Professor Shapiro uses SnePs, his semantic net processing system, to process the structures under investigation. The two groups continue to be in contact.

Professor Srihari and his students at SUNY Buffalo are investigating the role of shallow versus deep reasoning in diagnostic systems. They have been viewing the problem in the context of neurological diagnosis systems, but they are currently directing their attention to other domains, such as electronic maintenance. One of the major subtasks in system control problems for large communication systems is a function involving fault diagnosis and isolation. Professors Meyer and Conry feel that this diagnosis problem is one which will probably be most amenable to a problem solving paradigm that combines shallow and deep reasoning. It is exactly this type of paradigm that Professor

Srihari has been investigating. The potential for mutually beneficial cooperation in this area has been recognized, and initial exchange of ideas has occurred. It is anticipated that this interaction will grow.

One last area of mutual interest among institutions involves the University of Massachusetts and Clarkson. Professor Conry and her students at Clarkson have been working on mechanisms for automatically distributing LISP functions when they are implemented on multiprocessor systems. A simulator has been written and results to date appear to be promising. The only difficulty with the research to date has been the fact that a simulated environment has been necessary. As a result, some analysis of a worst case scenario has been required to ensure that all potential barriers to "safe" parallel execution are detected. These barriers would be easy to detect in an multiprocessor environment or in an emulated parallel environment. Dr. Corkill at the University of Massachusetts and his group are currently working on an emulator for a distributed environment. Professor Conry and Dr. Corkill believe that the emulated environment would be an ideal vehicle for experimentation with strategies of the kind that have been proposed.

Role of the Proposed Instrumentation

In a research environment as distributed as the one which exists in the Northeast Artificial Intelligence Consortium, special efforts must be made to facilitate the forms of close interaction which lead to meaningful results. Mechanisms are already in place for the exchange of faculty and for frequent visits among researchers. Indeed, one investigator has made use of his sabbatical opportunity to visit on an extended basis at the University of

Massachusetts. Another group of researchers plans to visit in Massachusetts during the summer and fall of 1986.

Above and beyond these opportunities, however, there is a need to transport software developed at one institution to facilities available at another. As is evident in the preceding sections, there is extensive interaction developing within the Consortium. This interaction will be beneficial to the research efforts already funded by the Department of Defense and should be instrumental in developing new areas of research of interest to the Department of Defense. In fact, all of the topics mentioned in the preceding sections lie in the area of artificial intelligence, one of the areas of research interest mentioned by all three services.

The major barrier to software portability within the Consortium is the lack of any common equipment and software development environment across the member institutions. This barrier has been recognized, but there has been no funding available to provide this equipment within current contracts. This proposal has been written to address the problem of software portability within the Consortium. It is envisioned that at least one of the machines purchased under this program would be located at each of the member institution campuses and would be dedicated to research on the topics mentioned in this proposal. This proposal has the endorsement of the following Air Force personnel:

Dr. Fred Diamond, Chief Scientist, Rome Air Development Center
(see attached letter)

Dr. Northrup Fowler, Technical Manager, AI Consortium Project

Mr. Donald Gondek, Program Manager, AI Consortium Project

Project Engineers for the Consortium Tasks:

John G. Parker RADC/IRAA	Donald Bush RADC/IREE
Robert Roberts RADC/IRDT	Dale Richards RADC/RBET
Charles J. Meyers RADC/DCLD	Douglas White RADC/COES
Raymond Liuzzi RADC/COES	

In any undertaking of this kind, spanning a considerable geographic region and a variety of university campuses, coordination of equipment acquisition and placement is a difficult task. Dr. Robert F. Cotellessa serves as Principal Investigator for this proposal. In his capacity as Managing Director of the Northeast Artificial Intelligence Consortium, Dr. Cotellessa has reviewed the equipment available on each of the member institution campuses. A summary of the systems available for research in artificial intelligence is given in the table below. It is evident from that table that there is no commonality of environments across the Consortium. Some of the institutions have a great deal of software written in Franz LISP (Rochester and Buffalo) while others use a locally developed dialect (Massachusetts) and still others are using mixed environments. It should be noted that the sheer volume of equipment available on some campuses is not indicative of adequate equipment availablity. In virtually every case, the use of hardware is dedicated to a specific task or group of tasks.

The proposed instrumentation, in the form of a group of dedicated LISP workstations, would enhance the research capabilities on each campus and provide the common environment needed for software exchange. As each campus converts to a Common Lisp environment running on a common machine, it will be possible to make much more progress during the brief meetings that are held

throughout the year. In addition, there are efforts under way to connect all the member institutions to a common network. With common hardware and software environments and access to the same network, collaborative research should be facilitated.

Equipment Available for Artificial Intelligence Research

SUNY Buffalo

(2) VAX 11/750	(1) VAX 11/780
(1) VAX 11/780	(1) SUN workstation

Clarkson University

(1) Symbolics 3670	(1) VAX 11/750
(1) Gould PN 9080	

ColgateUniversity

(1) Symbolics 3600	(1) VAX 11/750

University of Massachusetts at Amherst

(2) Symbolics 3600	(1) Symbolics 3670
(6) Texas Instruments Explorers	(7) VAX 11/780

Rensselear Polytechnic Institute

(1) Symbolics 3670	(2) VAX 11/780
(10) SUN workstations	

University of Rochester

(4) VAX 11/750	(1) VAX 11/780
(10) SUN workstations	(20) Xerox Dandelions
(3) Symbolics Lisp Machines	

Rochester Institute of Technology

(1) Pyramid 90X	(4) VAX 11/780
(5) Massachusetts Computing 5000	(1) PDP 11/70

Syracuse University

(1) Symbolics 3670

(1) VAX 11/780

(1) IBM 4341-P12

(1) Analogic APL

General Supporting Information

Useful Life of the Equipment

It is anticipated that the useful life of this equipment will be determined largely by future developments in advanced LISP workstations. We estimate that useful life to be at least five years.

Recent Publications of Key Personnel

In this section, the research activity on the part of Consortium member institution faculty is documented. In lieu of curriculum vita for key personnel (other than the Principal Investigator), a list of the most recent publications of many of the researchers has been compiled. For the sake of brevity, this list has been restricted primarily to publications in calendar year 1985.

Allen, J. and P. Hayes, "A Common Sense Theory of Time", Proceedings of the Ninth International Joint Conference on Artificial Intelligence, August 1985.

Xiang, Z., S. Srihari, S. Shapiro, and J. Chutkow, "A Modeling Scheme for Diagnosis", Proceedings of the Expert Systems in Government Symposium, October 1985.

Kumar, R., and S. Srihari, "An Expert System for the Interpretation of Cranial CT Scan Images", Proceedings of the Expert Systems in Government Symposium, October 1985.

Pelavin, R., "A Formal Logic that Supports Planning with a Partial Description of the Future", to appear in the Proceedings of the IEEE Systems, Man, and Cybernetics Annual Conference

Woolf, B. P. and D. D. McDonald, "Understanding Discourse Conventions in Tutoring", Proceedings of the Expert Systems in Government Symposium, October 1985.

Conry, S. E. , R. A. Meyer, and J. E. Searleman, "A Shared Knowledge Base for Independent Problem Solving Agents", Proceedings of the Expert Systems in Government Symposium, October 1985.

Woolf, B. P., "Frontiers of Knowledge Based Tutors", Proceedings of the Expert Systems in Government Symposium, October 1985.

Durfee, E. N., V. R. Lesser, and D. D. Corkill, "Increasing Coherence in a Distributed Problem Solving Network", Proceedings of the Ninth International Joint Conference on Artificial Intelligence, August 1985.

Allen, J. F. "A Plan Recognition Model for Subdialogs in Conversation", Proceedings of the Tenth International Conference on Computational Linguistics, July 1984.

Nirenburg, S., "POPLAR: A Decision Making System that Uses Situational Knowledge, Proceedings of the IEEE Conference on Intelligent Control, August 1985.

Nirenburg, S., "Control Structure of POPLAR", in Proceedings of the Third Annual Conference on Intelligent Systems, August 1985.

Nirenburg, S., "Interlingua design in TRANSLATOR", Proceedings of the

International Conference on the Theory and Methodology of Machine Translation. August 1985.

Nirenburg, S., and E. Lozinskii, "Parsing in Parallel", to appear in Journal of Computer Languages

DEPARTMENT OF THE AIR FORCE
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GRIFFISS AIR FORCE BASE, NEW YORK 13441

OFFICE OF THE
CHIEF SCIENTIST

8 Nov 85

Dr. Robert F. Cotellessa
Dean of Engineering
Clarkson University
Potsdam, NY 13676

Dear Dean Cotellessa,

I understand that the Artificial Intelligence Consortium is preparing a proposal for the purchase of equipment under the DOD-University Research Program. This equipment would provide common hardware for research by the Consortium members, so that software could be interchanged between Consortium researchers.

This use of common equipment would contribute significantly to the promotion of communications and collaboration, which is a key objective of the Consortium in realizing its goals.

RADC has made a long-term commitment to the Consortium with significant funding to assure quality and continuity. Each of the Consortium member institutions brings some Artificial Intelligence expertise to the Consortium, but collectively, they represent a far more powerful group. However, its success depends on strong interaction between members and the sharing of expertise and resources.

We recognize the challenges in applying and extending the state-of-art in artificial intelligence to useful, non-trivial solutions of Air Force problems. Current expertise is limited, and despite the promise of this technology, no overnight solutions are expected. But with well-defined goals, growing progress, and continued commitment to the development of expertise, we are confident in the potential of the Consortium to make major contributions to the evolvement of expert systems as effective tools in the Air Force inventory.

Sincerely,

FRED I. DIAMOND
Chief Scientist

END

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1988

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